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By: Kate Moore

HWK 2 0008P

PROVISIONAL APPLICATION UNDER 37 CFR 1.53(b)(2)
TRANSMITTAL LETTER

TO THE ASSISTANT COMMISSIONER OF PATENTS
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Transmitted herewith for filing is the Provisional Patent application of:

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CANADA

Entitled: **TOOL RIG FOR THE COMPACTION OF PARTICULATE MATERIAL**

Enclosed are:

12 Pages of **SPECIFICATION**

7 Sheets of **DRAWINGS** (FIGURES 1-10)

__ **VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS**

__ Independent Inventor

__ Small Business

__ Non-profit Organization

__ OTHER (Specify) ______________________

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Tool Rig for the Compaction of Particulate Material

Background of the Invention

Field of the Invention

The present invention relates to the art of forming products from particulate materials. More particularly, the present invention relates to the compaction of particulate materials. Still more particularly, the present invention relates to a new tool rig for the compaction of particulate materials.

Description of Related Art

In the manufacture of components or parts from particulate materials, a critical process is the compaction of the particulate material. Compaction is typically performed by filling a die cavity with the particulate material and applying pressure to the particulate material with a press.

The press has a driven main ram that moves in a single direction. The main ram is connected to a ram platen that moves with the main ram. In most cases, the main ram and ram platen move in a downward direction toward a base platen to perform the compaction. The main ram may be driven by hydraulic or mechanical means, as known to those skilled in the art. Depending on the operation, additional rams may be present to provide auxiliary motion in a vertical direction.

Press compaction may utilize different types of presses, among them a hybrid press and a hydraulic press. A hydraulic press includes a hydraulically driven

main ram and hydraulic auxiliary motions. A hybrid press comprises a crank or knuckle driven main ram and hydraulic auxiliary motions. Adjustable mechanical stops are used to prevent auxiliary motion beyond the desired range.

A density as close to the theoretical density of the material is desired for a component made from a particulate material, because the mechanical properties of the component improve with increasing density of the compacted particulate. As a result, techniques have been developed to increase the density achieved through the compaction process. These techniques are often focused on multiple level parts, because the geometry of multiple level parts usually makes uniform density distribution between the levels more difficult. This discrepancy in density distribution adversely affects the performance of the part and may lead to the formation of cracks in the compaction process.

One technique to improve compaction of multiple level parts is that of a tool rig comprising a die that defines a cavity and at least one punch that extends into the cavity. The punch is typically actuated through auxiliary motion at some point during the compaction process to move the punch to a different vertical position and thereby increase the flow of the particulate material in the cavity to achieve higher and more uniform density distribution in the formed part. For parts with many levels, multiple punches may be used and each punch may be separately actuated.

In order to facilitate these actuated punches, designs of prior art tool rigs have relied upon cumbersome designs. A tool rig usually includes platens and/or cylinders to support each punch. Each of these support components must be independently movable to allow each punch to be independently actuated. Likewise,

each support component must have an independent source of energy to create independent motion of the support component and its respective punch. Such sources of energy may include connections to hydraulic or pneumatic media. Further, each support component typically has a linear encoder that measures the position and travel of the component, in turn measuring the position and travel of the punch that the component supports.

The independent supply requirements of encoders and energy sources for each component that supports an actuated punch have necessitated the design of vertically long tool rigs and presses in the prior art. The vertical length of a press dictated by designs of the prior art is illustrated in European Patent No. EP 0 586 028 B1, issued to present inventor and others, in PCT Publication No. WO 01/08864 A1, issued to Beane et al, and in European Patent No. 0 077 897/related U.S. Patent No. 4,482,307, issued to Schaidl et al. This excessive vertical length increases the height of the die travel and dictates a taller press, which leads to increased deflection of the press and consumption of valuable production space.

Accordingly, it is desirable to develop a new tool rig that allows encoders and an energy source to be connected to the tool rig components without a substantial increase in height, reducing the problems of deflection and occupation of excessive production space.

Summary of the Invention

The present invention provides a tool rig for the compaction of particulate materials such as powdered metals.

In an exemplary embodiment of the present invention, a tool rig for the compaction of particulate materials includes an upper block disposed on a base. At least one cylinder is housed within the upper block. A core rod is disposed in the center of the tool rig and a central ring extends between the at least one cylinder and the core rod. The central ring defines a channel, whereby the central ring channel provides an energy supply to the cylinder.

In another exemplary embodiment of the present invention, a tool rig for the compaction of particulate materials includes an upper block disposed on a base. A first concentric cylinder is spaced from a second concentric cylinder and the first and second concentric cylinders are housed within the upper block. A central ring extends between the first and second cylinders and defines a channel, whereby the central ring channel provides an energy supply to at least one of the first and the second cylinders.

In yet another exemplary embodiment of the present invention, a tool rig for the compaction of particulate materials includes at least two concentric cylinders with at least two of the cylinders located at essentially the same elevation. A base plate located at an elevation different than that of the at least two cylinders supplies hydraulic power to a wall of each of the at least two cylinders. Linear encoders to measure the position of the at least two cylinders are included in the base plate. The base plate provides for a mechanical stop for at least one of the at least two concentric cylinders. The mechanical stop may be adjustable.

In still another exemplary embodiment of the present invention, a press includes a tool rig for the compaction of particulate materials.

Brief Description of the Drawings

The invention may take form in certain components and structures, exemplary embodiments of which will be illustrated in the accompanying drawings, wherein:

FIG. 1 is a front sectional view of a tool rig in accordance with an embodiment of the present invention;

FIG. 2 is a plan view of the base of the tool rig of FIG. 1;

FIG. 3 is a plan view of the tool rig of FIG. 1;

FIG. 4 is a front sectional view of a tool rig in accordance with another embodiment of the present invention;

FIG. 5 is a top sectional view of the base of the rig of FIG. 4;

FIG. 6 is a front sectional view of a tool rig in accordance with yet another embodiment of the present invention;

FIG. 7 is a plan view of the tool rig of FIG. 6;

FIG. 8 is a front sectional view of a tool rig in accordance with another embodiment of the present invention in a fill position;

FIG. 9 is a front sectional view of the tool rig of FIG. 8 in a compacting position; and

FIG. 10 is a front sectional view of the tool rig of FIG. 8 in an ejection position.

Detailed Description of the Preferred Embodiments

With reference to FIG. 1, a tool rig **66** designed to support three upper and three lower punches is shown. The tool rig includes an upper half **68** and a lower half **70**. The upper half **68** is substantially a mirror image of the lower half **70**, thus, reference herein will be made only to the lower half **70** but will be understood to include the upper half **68**. The lower half **70** of the tool rig **66** includes an upper block **72** and a base **74**. Housed within the upper block **72** are an outer concentric cylinder **76**, a middle concentric cylinder **78** and an inner concentric cylinder **80**. These cylinders **76**, **78** and **80** provide support for the lower punches (not shown) and are movable along the vertical axis of the tool rig **66** in response to the supply of an energy source, such as hydraulic fluid. A central bore **82** for the core rod (not shown) is defined in the inner diameter of the inner cylinder **80**. Disposed between the middle cylinder **78** and the inner cylinder **80** is a stationary central ring **84**. The central ring **84** allows access to the middle cylinder **78** and the inner cylinder **80** for the supply of the energy source from between the cylinders **78**, **80**.

Housed within the base **74** of the lower half **70** of the tool rig **66** are linear encoders. A linear encoder **86** for the outer cylinder **76**, a linear encoder **88** for the middle cylinder **78** and a linear encoder **90** for the inner cylinder **80** are all mounted within the base **74**. The encoders **86**, **88** and **90** extend from the base **74** into each respective cylinder **76**, **78** and **80** and measure the compaction cycle travel of the cylinders **76**, **78** and **80**.

The base **74** also defines supply channels **92** and **94**. These channels **92** and **94** facilitate the connection of the energy supply. The channels **92** and **94** continue

from the base **74** into the central ring **84** to provide the energy supply to the middle cylinder **78** and the inner cylinder **80**.

With continuing reference to FIG. 1, a pocket **96** is defined between the inner cylinder **80**, the central ring **84** and an inner seal ring **97**. A pocket **98** is defined between the middle cylinder **78**, the central ring **84** and a middle seal ring **99**. The seal rings **97** and **99** are fixed to the central ring **84**. Channel **92** supplies pocket **98** and channel **94** supplies pocket **96** with the energy supply, typically a compressible gas or hydraulic fluid. The inner cylinder **80** includes a radial projection **100** about its outer circumference that rides within the inner cylinder pocket **96**. The energy supply is provided to a lower portion of the pocket **96** via the channel **94** to urge the projection **100**, and hence the inner cylinder **80**, upward. The projection **100** travels vertically within the inner cylinder pocket **96** as dictated by the energy supply. The travel distance of the inner cylinder **80** and the punch it supports corresponds to the distance the projection **100** travels in the pocket **96**.

The middle cylinder includes a radial projection **102** about its inner circumference that rides within the middle cylinder pocket **98**. As with the inner cylinder **80**, the energy supply is provided to a lower portion of the pocket **98** via the channel **92** to urge the projection **102**, and hence the middle cylinder **78**, upward. The projection **102** travels vertically within the middle cylinder pocket **98** as dictated by the energy supply. The travel distance of the middle cylinder **78** and the punch it supports corresponds to the distance the projection **102** travels in the pocket **98**.

The outer cylinder **76** also includes a radial projection **104** about its outer circumference that similarly rides within a pocket **106** defined between an outer wall of

the upper block **72**, the outer cylinder **76** and an outer seal ring **108**. The outer seal ring **108** is fixed to the upper block **72**. The outer cylinder pocket **106** is connected to the energy supply through a channel (not shown) defined in the upper block **72**, typically from the side of the upper block **72**. As with the inner **80** and the middle **78** cylinders, the energy supply dictates the travel of the outer cylinder **76** and the punch it supports.

Turning now to FIG. 2, a top view of the base **74** of the lower half **70** of the tool rig **66** is illustrated. A port **110** for the linear encoder **86** of the outer cylinder **76** is defined in the base **74**, as are ports **112** and **114**, for the encoders **88** and **90** of the middle cylinder **78** and the inner cylinder **80**, respectively. The energy supply channel **92** for the middle cylinder **78** includes an inlet **116** and an outlet **118**. The energy supply channel **94** for the inner cylinder **80** also includes an inlet **120** and an outlet **122**. From this view, the connecting rods **124** of the die platen can be seen passing into the base **74**.

With reference to FIG. 3, a plan view of the lower half **70** of the tool rig **66** further illustrates the relationship between the cylinders **76**, **78** and **80** and the inner seal ring **97**, the middle seal ring **99** and the outer seal ring **108**. Also shown are the connecting rods **124** of the die platen.

Turning now to FIG. 4, a tool rig **128** to support two punches is shown. The tool rig **128** includes an upper block **134** and a base **136**. To support the punches (not shown), the tool rig **128** includes an outer cylinder **138** and an inner cylinder **140**, each of which is movable along the vertical axis of the tool rig **128** in response to the supply of an energy source, such as hydraulic fluid. A stationary central ring **144** is disposed in the inner diameter of the inner cylinder **140**. A central bore **146** for a core

rod (not shown), is defined in the central ring **144** and allows a central orifice to be formed in the part being compacted. The central ring **144** allows encoders and an energy supply to be connected to the inner cylinder **140** from its interior, eliminating the need for an inner cylinder that is longer than the outer cylinder **138**. The base **136** houses a linear encoder **148** for the outer cylinder **138** and a linear encoder **150** for the inner cylinder **140**.

Lower and upper channels **152** and **154** for the connection of an energy supply, such as hydraulic fluid, to the inner cylinder **140** are defined in the base **136** of the tool rig **128** and continue into the central ring **144**. A pocket **156** is defined between the inner cylinder **140**, the central ring **144** and an inner seal ring **157**. The inner seal ring **157** is fixed to the central ring **144**. The pocket **156** includes an upper portion **158** and a lower portion **160**. The inner cylinder **140** includes a radial projection **162** about its inner circumference that rides within the pocket **156**. The lower channel **152** supplies the hydraulic fluid to the lower portion **160** of the pocket **156** to urge the projection **162**, and hence the inner cylinder **140**, upward. In this manner, the travel of the punch supported by the inner cylinder **140** is controlled. The upper channel **154** may be a pressure relief channel, or it may supply the upper portion **158** of the pocket **156** with hydraulic fluid to urge the projection **162**, and the inner cylinder, downward.

With continuing reference to FIG. 4, a pocket **164** is defined between the outer wall of the upper block **134**, the outer cylinder **138** and an outer seal ring **165**. The outer seal ring **165** is fixed to the upper block **134**. A radial projection **166** extends about the outer circumference of the outer cylinder **138** and rides within the pocket **164**. The hydraulic fluid is supplied to this pocket **164** through a channel (not shown) in the

upper block **134** to control the movement of the projection **166**, and thus the outer cylinder **138** and the punch that it supports.

An adjustable mechanical stop **172** may also be included in the tool rig **128** to allow the cylinders **138**, **140** to have an adjustable lower limit of movement.

FIG. 5 illustrates the base **136** of the tool rig **128** from a top view. The detail of the mechanical stop **172** can be seen, particularly the rod **174** that allows the stop **172** to be adjusted.

Turning now to FIG. 6, an alternative embodiment of the tool rig **128** to support two punches is shown. The tool rig **128** includes the upper block **134** and the base **136** of the prior example. The outer cylinder **138** and the inner cylinder **140** are present to support the punches (not shown). The central ring **144** is disposed in the inner diameter of the inner cylinder **140**. However, the lower and upper channels **152** and **154** for the connection of hydraulic fluid to the inner cylinder **140** are replaced by supply members **176** and **178**. In this embodiment, rather than pass through an inner portion of the central ring **144**, the supply members **176** and **178** extend directly through the base **136** to a lower portion of the inner cylinder **140**. Thus, the inner cylinder **140** may be urged upward by the hydraulic fluid from supply members **176** and **178**, and may be stopped by the adjustable mechanical stop **172** when the hydraulic pressure is released or overcome.

FIG. 7 further illustrates the relationship between the outer cylinder **138**, the inner cylinder **140**, the outer seal ring **165** and the inner seal ring **157** of the tool rig **128**. The connecting rods **180** of the die platen extend into the tool rig **128**.

With reference to FIG. 8, the two-cylinder tool rig **128** without the mechanical stop **172** is shown in a fill position. The tool rig **128** may include a die platen **182** that houses a die adapter **184**. The die adapter **184** receives a die **186** that defines a cavity **188**. The cavity **188** holds the particulate material or pre-form that is compacted by use of the tool rig **128**. On top of the inner cylinder **140** is an adapter **190**. The adapter **190** facilitates the support of an inner punch **192** by the inner cylinder **140**. Surrounding the inner cylinder **140** is the outer cylinder **138**. The outer cylinder **138** supports an adapter **194**, which in turn supports an outer punch **196**. This system of cylinders **138, 140** and adapters **190**, **194** allows the outer punch **196** and the inner punch **192** extend into the cavity **188** when the tool rig **128** is in the fill position. A core rod **198** is disposed in the central ring **144** and also extends into the cavity **188**.

Turning now to FIG. 9, an upper punch **200** may enter the cavity **188** when the tool rig **128** is in a compaction position. FIG. 10 illustrates the tool rig **128** in an ejection position, wherein a compacted part **202** is pushed out of the die **186** by the punches **192, 196**.

The use of the central ring reduces the excessive height required for a press that compacts parts made from particulate materials using multiple punches. This reduces the deflection of the press, thereby increasing the quality of the parts made and the life of the press. In addition, the press occupies less vertical production space.

The above examples have described in detail a tool rig a modular design to allow multiple rigs to be used on a single press. However, it is also anticipated that a press may be designed with the tool rig of the present invention as an integral component. A press that may utilize the tool rig either as a modular unit or as an

integral component includes a frame. The frame may provide main ram motion, actuation of the die and the core rod, and electric or hydraulic controls.

Particular note is made that at least two concentric cylinders of the tool rig of the present invention are at essentially the same level in a non-compacting position. Further, a base that is on a different level contains encoders and means to provide an energy supply to each concentric cylinder. The invention has been illustrated with respect to a tool rig that supports two or three punches. However, support of more punches may be accomplished using the design of the present invention.

The invention has been described with reference to the preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of this disclosure.

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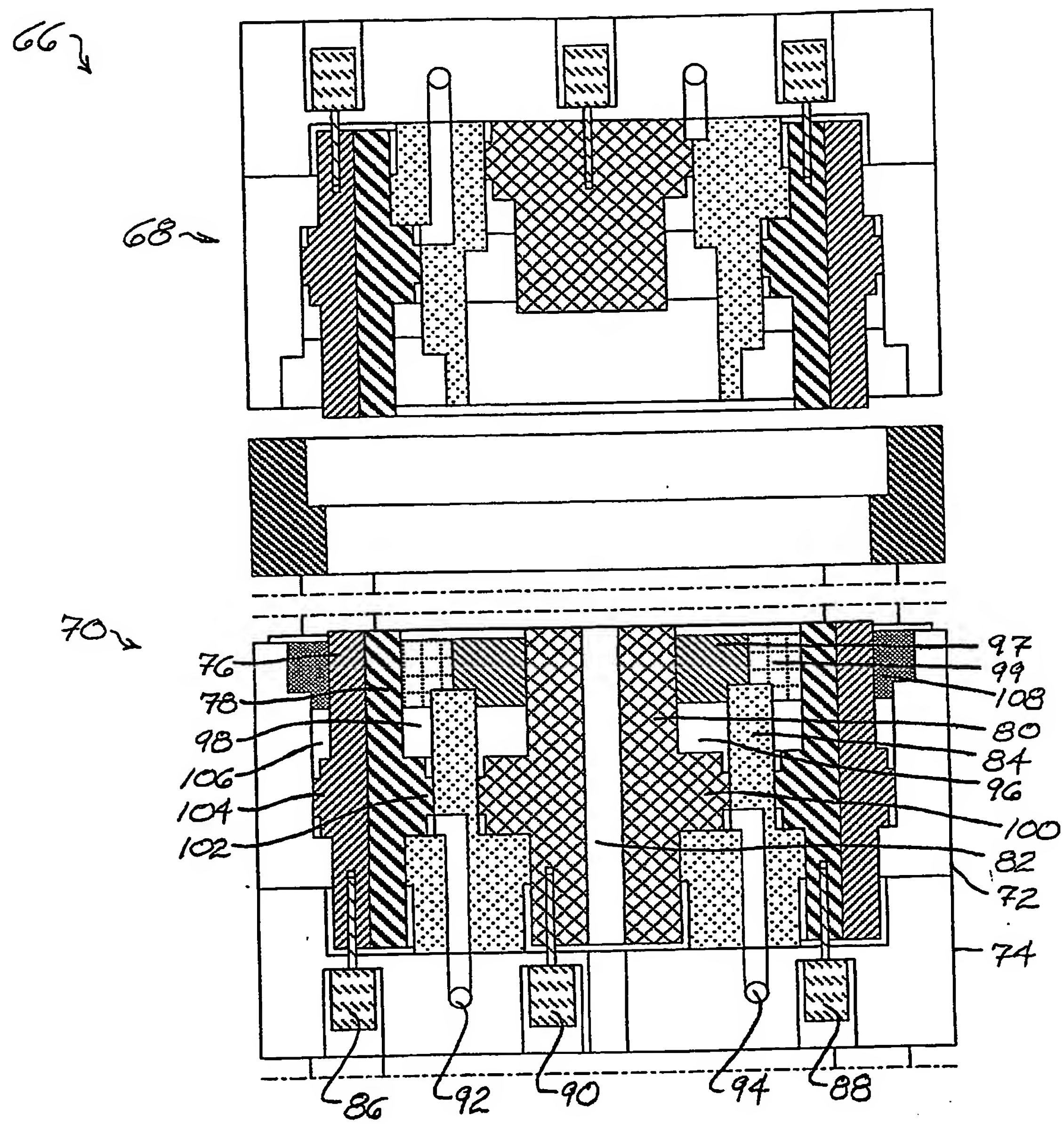
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FIG. 1

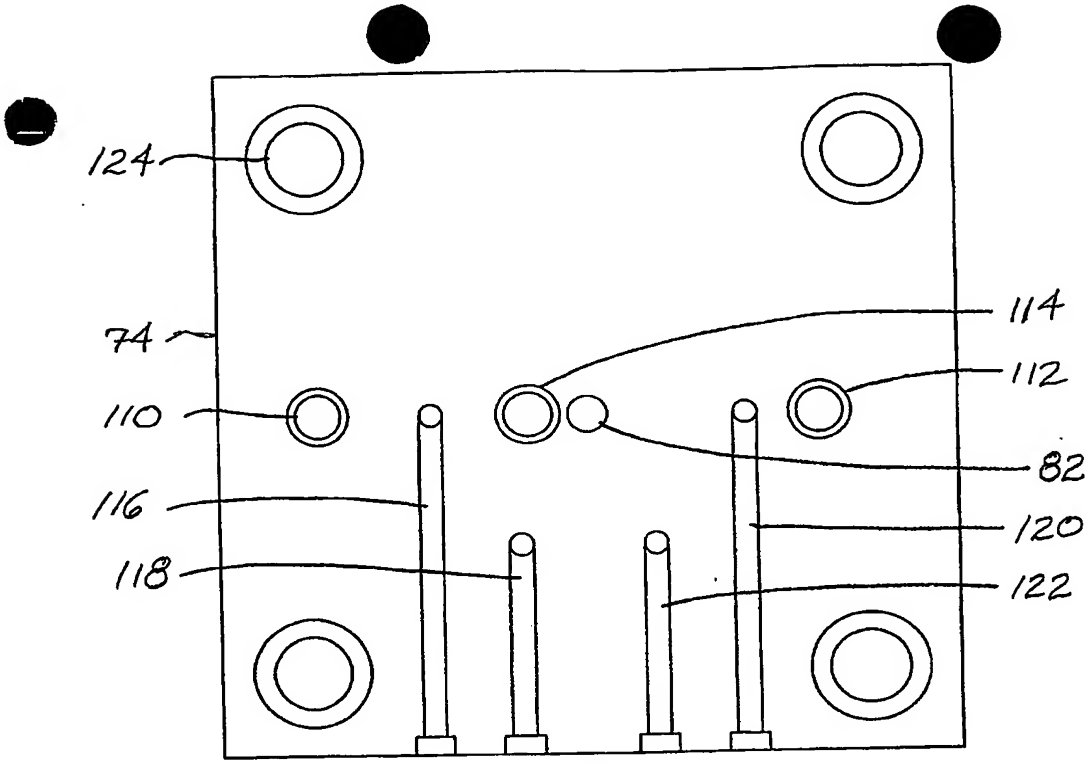


FIG. 2

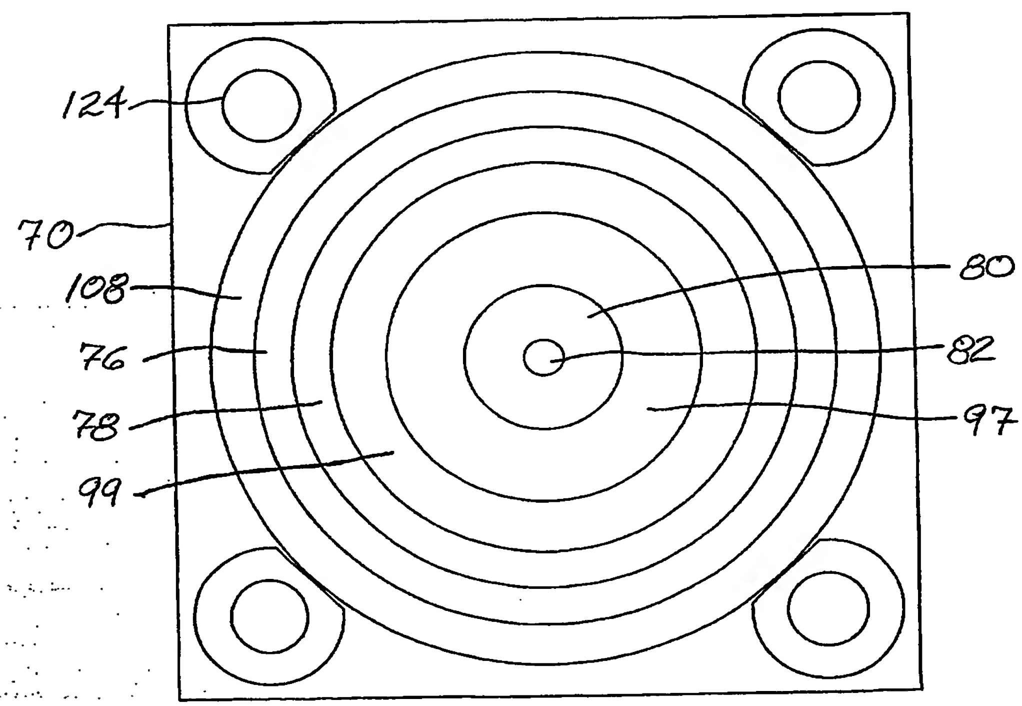
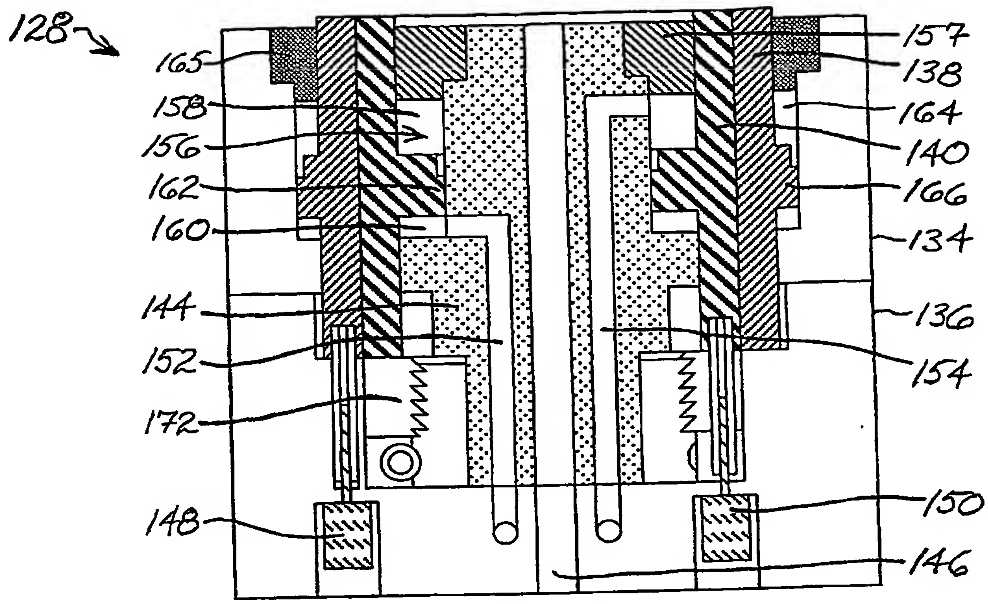


FIG. 3


128
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146

FIG. 4

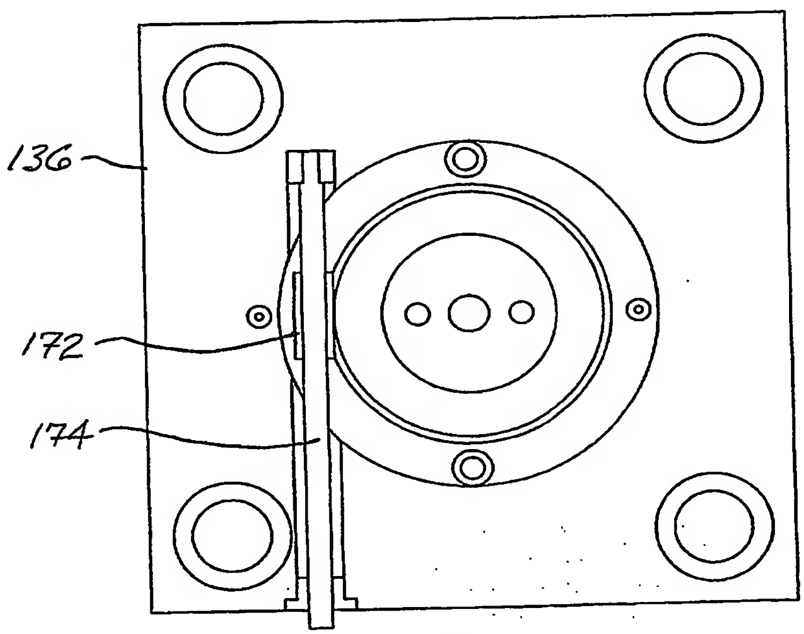
136
172
174

FIG. 5

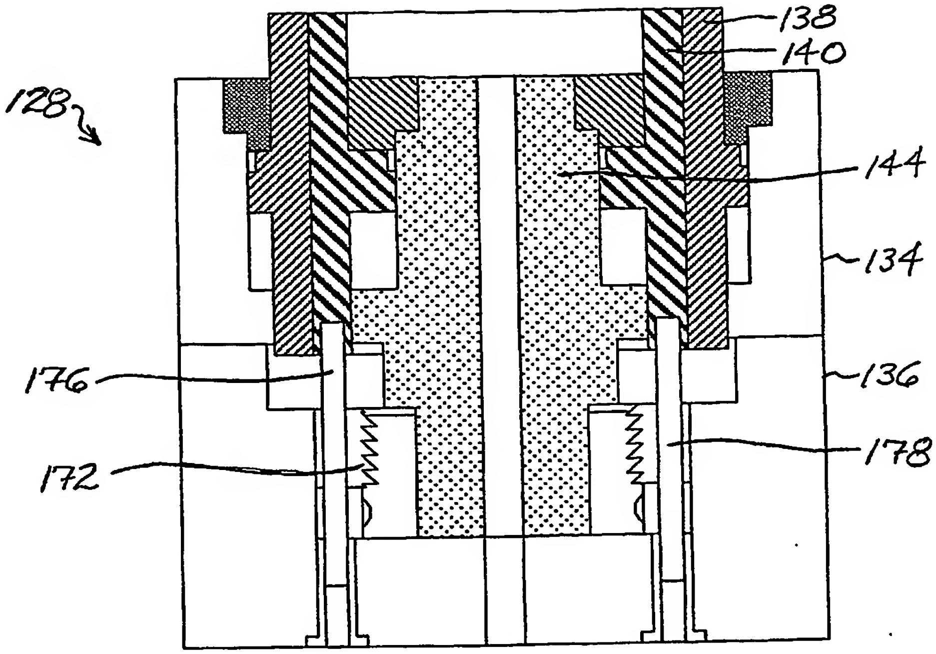

FIG. 6

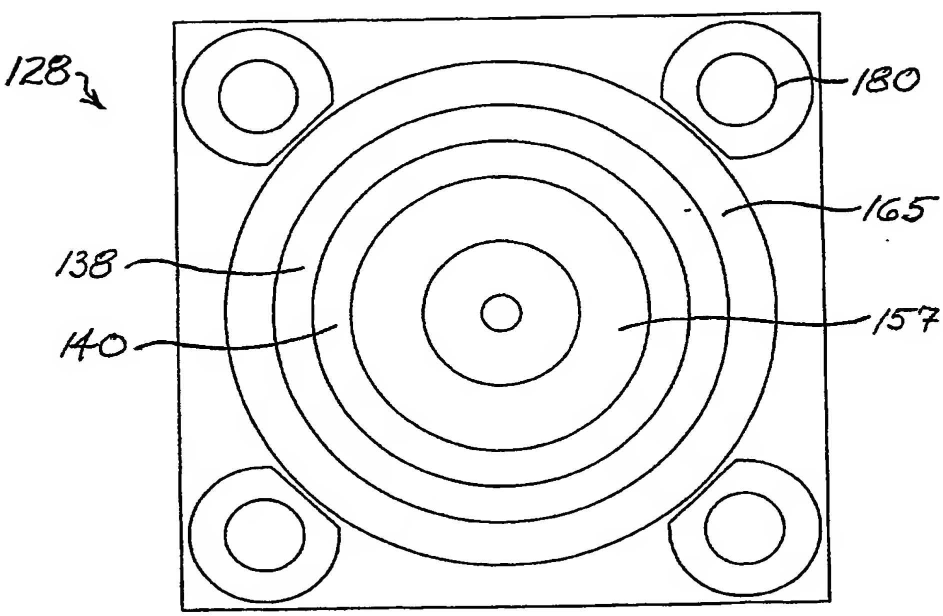

FIG. 7

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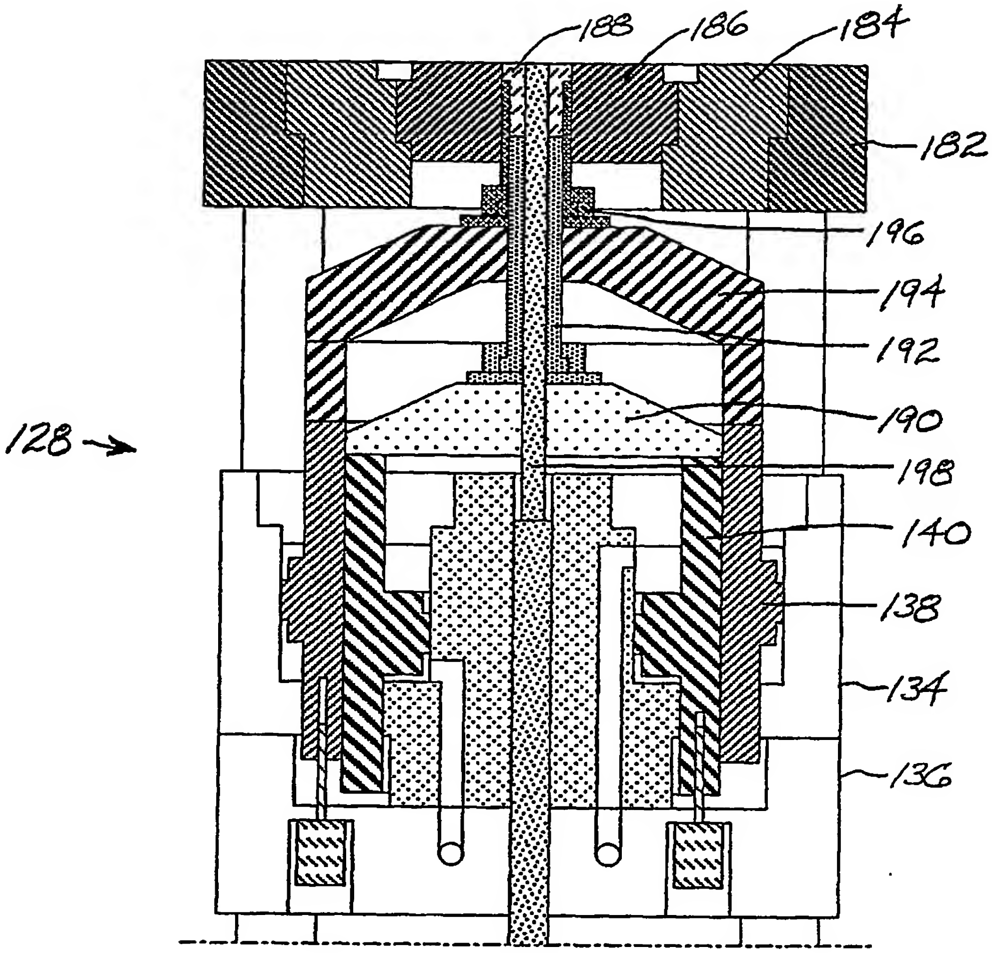

FIG. 8

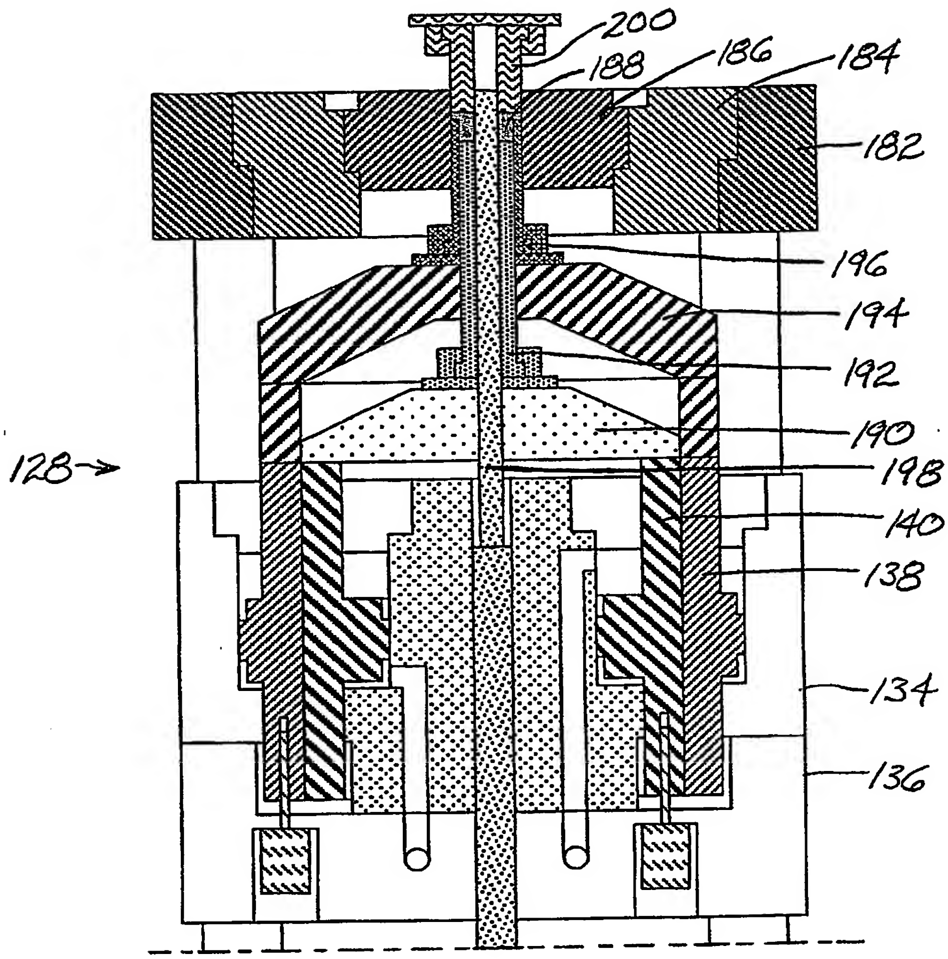

FIG. 9

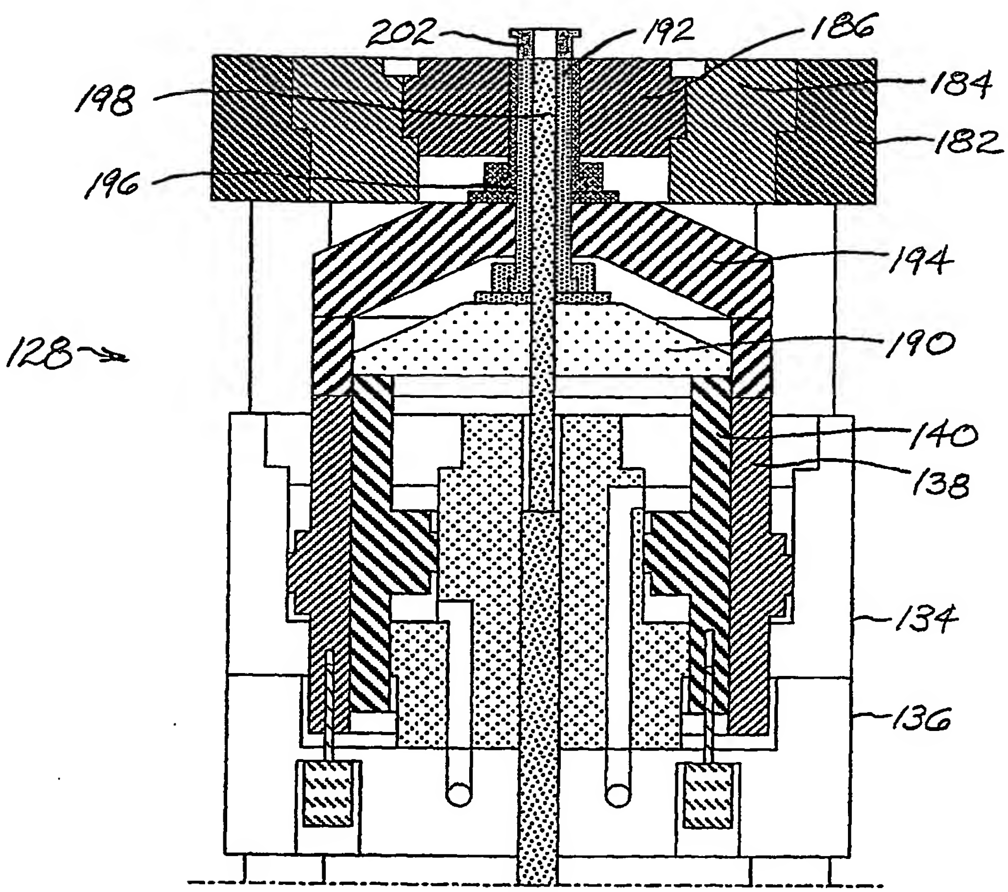

FIG. 10